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09 MAY 2003

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- 1) South African Patent Application No. 2002/2582 accompanied by a Provisional Specification was filed at the South African Patent Office on the 03 April 2002, in the name of **DE BRUYN, Henri Arnold** in respect of an invention entitled: **"Aggregate stabilizer"**.
- 2) The photocopy attached hereto is a true copy of the provisional specification and drawing filed with South African Patent Application No. 2002/2582.

Geteken te  
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PRETORIA

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in the Republic of South Africa, this

7th

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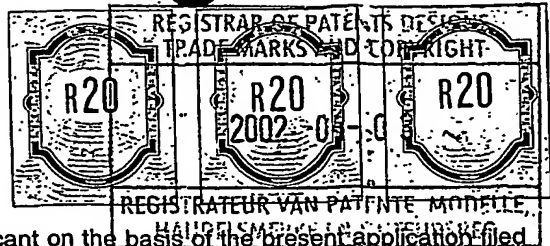
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(To be lodged in duplicate)

REPUBLIC OF SOUTH AFRICA				PATENTS ACT, 1978			
REGISTER OF PATENTS							
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71	HENRI ARNOLD DE BRUYN						
Applicants substituted:							
71							Date registered
Assignee(s):							
71							Date registered
Full name(s) of inventor(s):							
72	HENRI ARNOLD DE BRUYN						
Priority claimed		Country		Number		Date	
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Title of invention							
54	AGGREGATE STABILIZER.						
Address of applicant(s)/Patentee(s)		31 JACK BENNET ST					
		STERREWAG PRETORIA 0181					
Address for service		D. M. KISCH INC					
74	31 JACK BENNET ST, STERREWAG, PRETORIA 0181.						
Patent of addition No.		Date of any change					
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Fresh application based on		Date of any change					

## APPLICATION FOR A PATENT AND ACKNOWLEDGEMENT

[Section 30 (1)—Regulation 2  
(See notes overleaf)]

The grant of a patent is hereby requested by the undermentioned applicant on the basis of the present application filed in duplicate.

Official Application No.		(i) Applicant's or agent's reference	
21	01	AS 2	

(ii)		HENRI ARNOLD DE BRUYN
71	Full name(s) of applicant(s) .....	
(iii)		
Address(es) of applicant(s) .....		31 JACK BENNET ST STERREWAS, PRETORIA 0181

(iv)	54	Title of invention	AGGREGATE STABILIZER
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(v)	The applicant claims priority as set out on the accompanying form P 2.		
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(vi)	This application is for a patent of addition to Patent Application No.		
21	01		

(vii)	This application is a fresh application in terms of section 37 and based on Application No.		
21	01		

(viii)	This application is accompanied by:		
<input checked="" type="checkbox"/>	1.	A single copy of a provisional or two copies of a complete specification of.....8.....pages.	
<input type="checkbox"/>	2.	Drawings of.....0.....sheets.	
<input type="checkbox"/>	3.	Publication particulars and abstract (form P 8 in duplicate).	
<input type="checkbox"/>	4.	A copy of Figure.....0.....of drawings (if any) for the abstract.	
<input type="checkbox"/>	5.	An assignment of invention.	
<input type="checkbox"/>	6.	Certified priority document(s) (state number).	
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<input type="checkbox"/>	8.	An assignment of priority rights.	
<input type="checkbox"/>	9.	A copy of the form P 2 and the specification of S.A. Patent Application No.	21 01
<input type="checkbox"/>	10.	A declaration and Power of Attorney on form P 3.	
<input type="checkbox"/>	11.	Request for ante-dating on form P 4.	
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<input type="checkbox"/>	13.		

(ix)	74	Address for service:	D. M. KISCH INC. 31 JACK BENNET ST, STERREWAS, PRETORIA 0181
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Dated this 3rd day of APRIL 2002

Signature of applicant(s) or agent

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REPUBLIC OF SOUTH AFRICA  
PATENTS ACT, 1978

## PROVISIONAL SPECIFICATION

(Section 30(1) - Regulation 27)

Official Application No.			Lodging Date	
21	01	2002/2582	22	03 04 2002

Full name(s) of applicant(s)	
71	HENRI ARNOLD DE BRUNN

Full name(s) of inventors(s)	
72	HENRI ARNOLD DE BRUNN

Title of Invention	
54	AGGREGATE STABILIZER.

## AGGREGATE-STABILIZER

2002/4502

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This invention relates to a chemical binder forming a matrix with aggregate, the method use and application of such binder and matrix and the resultant matrix itself and an integrated system to achieve such matrix.

The chemical binder consists of urea formaldehyde precondensate reacting with urea and a catalyst, with or without other additives.

The components of the binder are mostly water soluble initially and can be mixed with water and/ or applied to aggregate, thus forming a matrix, or aggregate that can be applied to it or the matrix, resulting in a useable product or artifact.

The chemical reaction of the binder chemicals may be in phases i.e.:

- ♦ dissolving the urea in water or other solvent
- ♦ adding other alkaline substance(s) (optional) e.g. anionic bitumen emulsion to keep the pH of the solution alkaline for some time, or to increase the alkalinity or the volume of alkaline substances in the chemical mix.
- ♦ adding UFC (urea formaldehyde precondensate) at this pH of more than 7 where the addition phase of polymerization occur.
- ♦ the pH is then reduced with an acidic catalyst to approximately between 3-pH and 5-pH to enable the condensation phase of polymerization to take place.
- ♦ other additives could be added to the solution
- ♦ the solution and aggregate are then mixed together e.g. by pouring or spraying the solution and or into the aggregate or by mixing them together.
- ♦ the matrix is then compacted and left to dry or simply left to dry.

In a preferred embodiment of this invention the acid used is a weak organic acid e.g. acetic acid, citric acid, humic acids or other such acids or any other acid or any combination of these. These weaker organic acid catalysts take longer to facilitate the reaction than stronger inorganic acids.

This invention relates to the use of organics together with the UF resin, matrix and in the catalyst above. The binder sometimes does not adhere to the surfaces in a matrix such as soil, sand, clay or stone due to several factors such as moisture being or later coming in between the polymer and the aggregate, other impurities, physical factors e.g. or voids due to lack of compaction, physical shape or form, electrical and chemical bonding (e.g. van der Waal forces). These and other factors prevent or inhibit adsorption of the polymer at the interface with the aggregate in the matrix.

The use of humic acids present in soil or organic matter or synthetically added to the binder or aggregate has been found to improve the properties of the matrix.

In a preferred embodiment of this invention sugar and or other organics (e.g. humic acids) are added to the weak organic acid catalyst or to the binder or aggregate. The pH of Citric acid catalyst solution decreases from approximately 1.6 to 0.9 pH or less as the sugars are modified over a period.

This could lead to much improved adsorption of the polymers onto the interface with the surface areas of the aggregate and reduce or prevent later ingress of moisture.

It also may lead to better polymerization and strength due to larger molecular weights of the polymer and more polymerization in all directions in the matrix especially where a hydroxy tricarboxylic acid such as Citric acid is used, with three rather than two or one direction of polymer chain growth.

The use of excess formaldehyde in the UF ratio e.g. 1:2 urea to formaldehyde mol ratio or even more also is designed to provide for the reaction of many formaldehyde atoms per sugar or other organic atom. Lower or higher UF mol ratios may also be used e.g. 1:1.2 or 1 to 2.5

This invention further relates to the use of bitumen emulsion in the binder. During tests it has been established that anionic bitumen emulsion (60/40 suspension of bitumen in water with an emulsion) add further water resistance, strength and suppleness to the matrix. Bitumen is mainly a hydrocarbon at the end of the oil refinery process and also contains many organic substances that cause beneficial properties to the matrix as described above. Foamed bitumen or non-ionic or cationic bitumen emulsions can also be used. This invention further relates to bitumen emulsion being used in the compound and matrix. Anionic Bitumen Emulsion is preferred as its alkaline properties allow the use of more catalyst and humic acids described above, which improve the quality of the polymer, binder and matrix. Solids like bitumen, or latex separate somewhat near the surface of the aggregate during permeation, thus skin so formed helps to reduce formaldehyde emissions and return it for further strength reaction (rather than let it evaporate).

The use of latex in this invention has also been found to enhance the qualities of the matrix. This can be applied in emulsion form (cationic in the binder at lower pH or anionic in the aggregate at medium to higher pH). Latex imparts further water proofing, strength and suppleness characteristics to the matrix, while retaining the colour of the aggregate, thus resulting in a colourless binder.

This invention further relates to use of PVA (poly vinyl alcohol) as an additive to reduce the ingress of water into the matrix. Adequate molecular weight should be used e.g. between-500 to 2000 degree of polymerization.

This invention further relates to the addition of silanes to the compound or matrix. Silane polymers have been developed that bind with inorganic substances e.g. silicon oxides / soil on the one side of its polymer chain and with organics such as this UF resin binder on the other side. (e.g. Dynasylan). this greatly enhances adsorption onto the interface with the aggregate by a strong chemical bond between the silicon of say soil and the polymer chains in the matrix.

Other additives may increase results e.g. UV blocking agents, anti corrosive agents, portland cement to absorb excess water from the reaction or present for extra early or wet strength and to break the bitumen from its emulsion, buffers to control pH and allow more catalyst to be used for better strength, oxides to enhance colour of the matrix or change the pH of the chemical reaction, ammonium salts to neutralize excess chemicals or to reduce emissions or promote the chemical reaction, silicones, silanes, silanol oils or plasticizers.

In a preferred embodiment of this invention the free formaldehyde content of the UFC is reduced to reduce formaldehyde emissions e.g. 70% bound formaldehyde vs. 30% free formaldehyde or 88% bound formaldehyde vs. 12% free formaldehyde although the viscosity of the last example increases and shelf life decreases where in the first example it pours more easily and has a longer shelf life.

Usually UFC contains closer to 50/50 bound and free formaldehyde but even formalin could be used which contains no bound formaldehyde. UFC can be used in undistilled format which contains much more water which reduces emissions of

formaldehyde due to the hygroscopic nature of formaldehyde which is contained in the extra water as formalin.

This invention further relates to the use of an excess of formaldehyde in the urea : formaldehyde mol ratio. This allows the chemical reaction to take place over a longer period such as hours, days, weeks, or even months. This promotes further polymerization through more effective collisions occurring during this longer period whereas the reaction would have completed sooner with more urea in the U : F ratio. As the initial polymer chains must first form in the matrix before cross linking can take place (seconds or weeks later when effective collisions occur), then excess chemicals may cause more cross linking to occur later which causes much greater strength and water resistance of the polymer chains and matrix. These aspects of the invention together with a weak organic acid allows more working time and longer reaction time which is a new and unique property to form such matrixes.

The sequence in which the chemicals are used are of importance. It was discovered that less formaldehyde emissions occur when the urea is first dissolved in water, then bitumen emulsion added, then UFC, other additives and then the acidic catalyst. More of the addition and a faster chemical reaction is obtained when UFC is added to the urea, then the acidic catalyst (or these three together or in any sequence) and then the bitumen emulsion and possibly other additives.

The reaction time of the chemicals could be decreased to allow more working time especially at higher temperatures (e.g. summer or warmer regions) by using less catalyst or a buffer to react the chemicals at a relatively higher pH e.g. 4,5 pH. For a faster reaction time the pH could be reduced by more catalyst to say 3,5 pH or below. Too extreme pH during reaction results in a weaker polymer forming. Less or more catalyst may also be used to reduce effects of too alkaline or acidic water or soil in the aggregate.

Water forms an important and integral part of the binder to dissolve urea granules, to dilute the solution for easy pumping or spraying, to contain highly water soluble formaldehyde vapours in the solution or matrix, for better strength and less emission. Water is further an excellent and low cost spreading agent to promote permeation of the binder into the aggregate for consistent strength throughout the matrix:

It is a novel and unique part of this invention that this initially water soluble binder (excluding the bitumen) spreads where the water goes through fine soils or particles and even into little clods. All solid binders e.g. cement, lime, bitumen remain on top of or on the outside of clods or aggregates rather than penetrate into these aggregates. This allows this gravity fed or pumped binder to be used to form support structures or columns underground by permeation from holes drilled into the ground, e.g. embankments or supporting weak foundations etc; without digging out and replacing the soil.

A further novel part of this invention is that a (more solid) portion of the binder when sprayed onto or into the aggregate can now remain on or near the top of the aggregate while the remainder of the binder permeates deeper into the aggregate, both hardening the aggregate but in different ways. When sprayed onto e.g. soil the solid bitumen breaks and remain on or near the top of the aggregate while the UF resin goes where the water goes deeper into the aggregate. This forms a hardened matrix in different layers where the bitumen content can be adjusted to allow evaporation of water vapour through the not entirely dense bitumen skin on or near the surface of the aggregate. This allows the matrix to dry out while the bitumen skin

forms a protective skin to prevent water e.g. rain in liquid form to penetrate into the matrix. This bitumen is further strengthened by some of the remaining UF resin in the same area. A higher bitumen dosage forms a water impermeable skin on or near the surface.

The same principles as above but using clear latex or other colourless or coloured solids in the binder e.g. clay or silt or say sandstone particles to provide an attractive coloured skin (instead of black bitumen) to e.g., retain the natural appearance of soil or reduce painting cost or furnish other attributes to the matrix or only the surface of the matrix. This can be done at lower cost than using these solid additives throughout the matrix. Portland cement could thus be added to furnish early and additional wet strength on or near the surface, drying out moisture, breaking the bitumen from its emulsion etc.

The above invention forms an excellent dust inhibitor which keeps fine particles of the aggregate in the matrix, which becomes water insoluble and does not leach out once reacted. This layer of hardened aggregate has more wet and dry strength which can handle traffic, wear, prevent plant growth e.g. grass for firebreaks, foot paths, dust free areas in agriculture etc. next to wine, citrus or tomato farms the plants and crops do better, less poison is sprayed to contain red spider or other pests needing dust to survive on fruit.

The amount of water used in this invention for effective application is important and forms part of the invention and eventual matrix although some of it or all of it may later evaporate or dry out later (after application).

For road building and obtaining optimum compaction, soil has to be brought to OMC (optimum moisture content) for that soil. This is easily calculated by determining the amount of water to be added e.g. 3% to a small sample of aggregate to get it to OMC for best compaction (keep adding 1% at a time to soil until it makes a ball in your hand or measure in a laboratory). This amount of water will result in much more strength in the aggregate for mix-in applications that are compacted. For spray-on or sand-seal applications much more water can be used, where the water becomes a very effective spreading or permeating agent apart from being a solvent, which also forms part of this invention. This economically spreads the binder over the desired area, to the desired depth or enables it to be pumped over a distance e.g. spraying an embankment, thus obtaining the desired dosage rate of binder in the aggregate and forming an effective matrix or several different strengths or attributes in the same matrix e.g. more binder added while water soluble in the outer areas of bricks, blocks, tiles, roads etc. Water and raking spreads the chemicals evenly in these areas.

A further aspect of this invention is that this binder does not need curing with water (as does cement) but is simply left to dry.

This invention relates to an initially water soluble binder which is mixed with water and then mixed into or sprayed (poured, permeated) onto or into an aggregate where it then reacts chemically at ambient temperatures to form an effective water insoluble binder, resulting in an effective matrix when left to dry or shaped and compacted into the desired form. Solids that are not initially water soluble could be used with the binder or suspended in water or solvents with emulsions.

Ambient temperatures during reaction can vary from below 0° C to above 50° C which further forms part of this invention with no baking or heating required.



This invention further relates to compaction of the aggregate after the binder had been mixed in or sprayed onto the aggregate. This forms an integral part of the invention as the aggregate e.g. soil particles are pushed closer together by compaction, whereafter the polymer chains grow and cross link in all directions around and in the particles to form a network of polymer fibres in the matrix. This then binds and keeps the particles together in the desired position in the matrix and increases the friction between particles and therefore the compactive, tensile and other strength in wet or dry conditions.

The aggregate in the matrix may contain different solids e.g. clay, sand, gravel, rock, soil, organic materials, fibres (natural or synthetic), coal rubber (e.g. shredded tyres), waste materials (e.g. oil or polluted soils), ash, wood carvings or dust, or other solids such as grass, metal ores, salt or other components.

The aggregate should preferably be continuously graded i.e. from very small to small to medium to larger particles.

It is an important aspect of this invention that this binder binds fine particles together well in a matrix where many other binders fail to do so. This binder is not glue to glue rocks together but works well with coarser particles (such as gravel or stone) when there are fine particles between the coarse particles.

As the aggregate forms an important part of the eventual matrix fines or coarser materials could be added to improve the strength if deficient of the end product. (Often available from nearby)

The eventual matrix or artifact then consists of the chemical binder, water (evaporated or not), aggregate and compaction (or no compaction).

The method of application could be mixing the chemicals, water and aggregate together (in any sequence), shaping it into the desired form and then compacting it, leaving it to dry.

Alternatively the chemicals and water (or no water except the water in the chemicals) could be sprayed onto or poured or pumped onto the aggregate, then compacted (or not) and left to dry.

A benefit of this binder is that this can mostly be applied with conventional equipment.

The first mix-in / compact method can result in a hardened slab, block or tile to be used in the construction of roads (base or sub base layers or wearing course), to make bricks, blocks, tiles, floors and many other products e.g. dam linings, canals etc.

Some additional chemicals may then be sprayed, poured or mixed into the surface or other areas of this slab before compaction, spread (e.g. by rake) or simply compacted. This forms a stronger outer or top layer to the slab which can withstand heavier loads or more wear, while the reminder of the slab is strong enough and at lower cost (rather than hardening the entire slab at higher cost).

When the binder (mostly with water) is sprayed or poured onto or into the aggregate (and compacted or not) this forms a seal to the aggregate e.g. soil. This has major benefits as the binder:

- ♦ lets water run off the surface of the hardened aggregate
- ♦ keeps the fines of the aggregate in the matrix
- ♦ keeps the lower layers dry and strong e.g. road slab layers.

This also applies to the mix-in / compact method above or when a solid component of the binder (e.g. bitumen or latex) remains on or near the surface of the aggregate after permeation, it further promotes these benefits.

A further application method of this invention is to form an extra layer of binder chemicals mixed with the same or different aggregate onto the surface of such a slab, hardened or untreated aggregate. This could be achieved by spraying or pouring binder (and water) onto the surface of other aggregate, placing sand or other solids onto this wet binder and repeating this process until e.g. a sand seal of say 6-mm thick is achieved on a road surface. This could also be done on a brick or floor to achieve e.g. a sandstone appearance that does not have to be painted.

Thus one matrix may consist of one or more or several different matrixes or different sub matrixes forming an effective end product or artifact. e.g. the surface of a hardened slab may be further strengthened by adding more chemicals onto or near the surface (at or near OMC) increasing the chemical dosage or altering the chemical ratios and other materials in this area.

This could be done by spraying / pouring more or different chemicals onto the previous slab before compaction, raking it in if necessary and compacting it or leaving it to dry.

To this surface hardened slab could be added a chemically hardened sand seal to further protect the surface area from wear. This could also be done later as maintenance or for preventative maintenance. These three matrixes could be supported by a differently sprayed on matrix onto a sub layer that supports the slab. Different chemical ratios and or additives, moisture content or degree of compaction or shape could be used in different parts of the final matrix.

In this example four different matrixes form one larger matrix to support traffic in a road.

A further aspect of this invention is that the binder weighs relatively little e.g. 58 kg chemicals to harden 1m<sup>3</sup> (one cubic metre) (say 1900 kg) of soil.

A further aspect of this invention is that this binder hardens a very wide range of soils effectively. Thus in situ soils can often be used without having to replace these soils with better quality soils. It also binds fine particles, which few or no other binders bind effectively or economically.

The above factors reduce transportation and handling costs substantially as less chemicals are transported to site and soils or aggregate often do not have to be transported from or to site.

#### EXAMPLE OF MAKING SUCH A MATRIX:

1. Place 1 kg (1000 g) of continuously graded soil sample in a mixing bowl.
2. Establish the moisture content whereby this soil compacts optimally e.g. 5% (5 percent) water added (weight / weight). Put this 50 grams of water in a mixing vessel.

3. Add 7 grams of urea granules to the water and stir for 15 minutes or until dissolved.
4. Add 15 grams of bitumen emulsion (anionic)
5. Add 22 grams of UFC
6. Add 1 gram of citric acid previously treated with sugars – dissolved into it (say 30% concentrate)
7. Add 1 gram humic acids (reduce or increase acids if pH is less than 3 or more than 5)
8. Add the other additives as required e.g. silanes 0,2% of the weight of the resin above i.e. 1 gram
9. Mix thoroughly with the soil.
10. Mix 2 grams of latex with 8 grams of water and mix this well into the aggregate.
11. Mix 5 grams of the chemicals in 3 to 8 above with 5 grams of water and spray onto aggregate, rake or mix into top 15 mm (at OMC +1%).
12. Compact well
13. Let dry at ambient temperature – Do not cure with further water as for cement.

#### EXAMPLE 2

1. Follow steps 1 to 8 above.
2. Spray the liquid onto the surface of the soil
3. Spray the liquid of steps 10 above onto the soil (only permeate or mix in).
4. Let dry until closer to optimum moisture content.
5. compact (less compaction than in example 1 or no compaction).
6. Let dry - Do not cure with water.

It is an important aspect of this invention that the chemical reaction takes place at ambient temperatures. This matrix thus formed makes it possible to use abundant materials e.g. a wide range of soils to construct roads, make bricks, floors, stabilize embankments, form pond linings etc. at low cost without having to bake such aggregates to harden it into a matrix.

A further aspect is that this can be done, in a user and eco friendly and economical way with conventional equipment, thus creating an effective new building material.

Layers of different matrixes can be constructed to obtain different strengths at different costs or different water levels of water impermeability – simply add more or less chemicals to different layers and a workable road surface or water impermeable brick is obtained at low cost. (Rather than make the whole matrix strong to get a stronger surface).

This invention further relates to a product or artifact made from the above materials and/or per the methods described above and the use thereof.

An effective matrix can be obtained by optimally combining the following major (and other minor factors), constructed by using the method and system described above.:

1. Using the best soil or aggregate available economically at a particular location, or importing and mixing other soil or aggregates into this aggregate to obtain a more continuous grading of particles or other properties desired or available.

2. Batching and mixing the chemicals in optimal ratios.
3. Mixing these chemicals with the correct amount of water to obtain optimum or effective compaction and or permeation of the aggregate.
4. Mixing the aggregate, chemicals and water together or allowing the permeation of the liquids, solids and gases into an effective mix in the aggregate.
5. Causing the desired form of the matrix by shaping or permeating the aggregate and matrix into this form.
6. Compacting the matrix in this form or allowing the mixed in or permeated chemicals to set and dry in this form.

This invention further relates to a product or artifact made from the above materials and / or per the methods described above and the use thereof in roads, housing, structures, stabilization, water storage, erosion control, canals, ponds, underground grouting and many other uses.

This invention specifically relates to the optimum combination of all the above factors as a new unique and whole system to produce an effective result, matrix or end product. Such optimum ratios, quantities etc., of chemicals, water, aggregate, compaction etc and the method used can be tested, piloted and designed as a whole to achieve the desired matrix(es)

Havivachung -

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